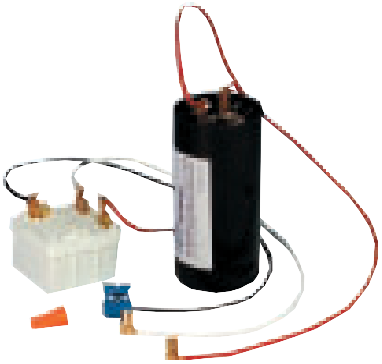
# CHOOSING THE RIGHT HARD START FOR THE APPLICATION

Single phase air conditioners and heat pumps that use non-bleed thermostatic expansion valves (TXV's) to control refrigerant need a hard start kit installed in the outdoor unit.



The problem with TXV's is that when a reciprocating compressor shuts off, refrigerant pressures don't fully equalize. Pressures do equalize in scroll compressors. Typically, scrolls do not need hard start kits. In a reciprocating compressor, the discharge pressure will drop to about 150 psig and the suction pressure will rise only to about 100 psig. When the compressor tries to start, there's too much load for the starting motor torque to overcome. This is especially true if the supply voltage is low.

To increase starting torque, several start assist devices can be used. When a TXV is used, the most reliable method is to use a true hard start kit such as the Supco SK3W Series. This can increase starting torque by a factor of 3 (300 %) over using just a run capacitor. Figure one (1) shows the wiring diagram for a 3-wire hard start.

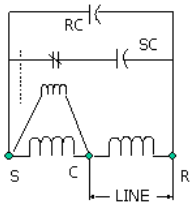



**Figure 1**

**3 Wire Connection**

The potential relay opens at manufacturer's specified voltage across the start winding of the motor, effectively removing the start capacitor from the circuit. A third wire is necessary to connect to the run winding.

The start relay has normally closed contacts, so when the compressor contactor closes, both the run and start capacitors connect to the start terminal. This causes a very high current to go through the start winding when power is first applied. This high start current increases the starting torque of the compressor motor enough that the motor will start even though the refrigerant pressures haven't equalized.

Once the compressor begins running, the voltage across the start winding increases. This occurs because the motor acts partly like a generator and partly like a transformer. The start winding is connected to the start and common terminals on the compressor, the same as the coil on the start relay. When the voltage across the start-to-common winding increases above the drop-out rating on the start relay coil, the start relay contacts open. The start capacitor is then out of the circuit.

There are two reasons the start capacitor can't stay in the circuit full time.

1. The start winding of the compressor can't carry such a heavy current continuously without overheating and burning out.
2. The start capacitors are made very compact and would overheat in a short while because they aren't big enough to dissipate heat as rapidly as it's generated.

The plastic casing on the start capacitor also plays a role in its tendency to overheat. When a start capacitor does overheat, the little putty filled hole in the top of the capacitor blows, and all the fluid inside runs out, causing the capacitor to fail.

A more convenient method for providing increased torque to the compressor is the 2-wire hard start device. In this case, the device can add as much starting torque as a 3-wire hard start, but installation is made simpler and cost is usually lower. Figure two (2) shows the wiring diagram for a 2-wire hard start.

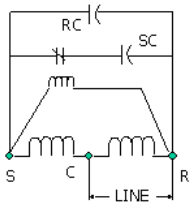



**Figure 2**

**2 Wire Connection**

The potential relay and start capacitor are connected across the run and start winding. The potential relay opens at a specified increment above line voltage, thus removing the start capacitor from the circuit. There is no need for a third wire.


The Supco E Class and HT Series hard starts are 2 – wire devices that include an Electronic Potential Relay (EPR) and start capacitor. The relay contacts for the HT Series have the highest current (amp) rating of any 2-wire hard start device. Both are voltage sensing and offer instant re-start. The voltage sensing method monitors the start winding developed voltage and actuates the electronic potential relay (EPR) to disengage the start capacitor. The EPR is inherently more reliable and precise than the older type mechanical potential relay. It acts like the drop out of the start relay coil in a 3-wire application. The HT Series and E Class hard start kits also employ a backup timing safety circuit for ultimate protection of the compressor. Their two wire installation is done on 120 or 240 volt PSC (permanent split capacitor) and CSIR (capacitor start induction run) type compressors.

Systems with capillary tubes or fixed restrictors usually don't need a full hard start kit, unless the compressor bearings are tight. In such cases, the compressor is probably near the end of its useful life anyway.

These types of systems usually need only a start assist device such as the Supco SPP Series. This device includes a PTC (positive temperature coefficient) relay wired in series with a start capacitor. Start assist devices are wired in parallel with the run capacitor and use only two wires. The PTC adds current to the start winding without shifting its phase.

If the PTC is wired in series with a capacitor, the start winding current is also phase shifted. When current passes through the PTC, it gets hot. The resistance of the PTC goes up, as it gets hotter. This increases the heat output so the resistance goes up even more. The effect is that the PTC is super boosted and taken out of the circuit in just a few seconds.

There is one type of TXV that doesn't need a true hard start kit to start the compressor. That is a bleed port TXV which has a small hole, drilled through the TXV seat. This type of TXV will equalize refrigerant pressures during the off cycle.

| Hard Start Comparison | HT Series | SPPE Series | SK3W Series | SPP Series |
|---|---|---|---|---|
| Start Sensing Technology | Voltage | Voltage | Voltage | NA |
| Uses Electronic Potential Relay (EPR) | Yes | Yes | Yes | No |
| Instant Re-Start | Yes | Yes | Yes | No |
| Senses Motor Start | Yes | Yes | Yes | No |
| Two wire, non-polarized | Yes | Yes | No | Yes |
| OEM Style, 3-wire | No | No | Yes | No |
| Replaces 3-wire capacitor kit | Yes | Yes | Yes | Yes |
| UL approved | Yes | Yes | Pending | Yes |
| PTCR Device | No | No | No | Yes |
| Backup Timing Safety Circuit | Yes | Yes | No | No |
| Potentially damaging to motor windings | No | No | No | No |
| Requires non-replaceable fuse protection | No | No | No | No |
| 330V Capacitor | Yes | No | Yes | No |

Excerpts taken from Hard Start Kits: When and How To Use Them, by Kevin O'Neill, CM, "Contracting Business", July 1, 2003

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